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Dose dependence of ferromagnetism in Co-implanted ZnO

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Abstract

We have studied the structural, magnetic, and electronic properties of Co-implanted ZnO(0001) films grown on Al2 O3 (11 2- 0) substrates for different implantation doses and over a wide temperature range. Strong room temperature ferromagnetism is observed with magnetic parameters depending on the cobalt implantation dose. A detailed analysis of the structural and magnetic properties indicates that there are two magnetic phases in Co-implanted ZnO films. One is a ferromagnetic phase due to the formation of long range ferromagnetic ordering between implanted magnetic cobalt ions in the ZnO layer and the second one is a superparamagnetic phase, which occurs due to the formation of metallic cobalt clusters in the Al2 O3 substrate. Using x-ray resonant magnetic scattering, the element specific magnetization of cobalt, oxygen, and Zn was investigated. Magnetic dichroism was observed at the Co L2,3 edges as well as at the O K edge. In addition, the anomalous Hall effect is also observed, supporting the intrinsic nature of ferromagnetism in Co-implanted ZnO films. © 2009 American Institute of Physics.

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